

WARING (G. E.) Jr

THE MEMPHIS SEWERAGE SYSTEM.

REPORT OF CONSULTING ENGINEER.

HON. W. L. CLAPP, President, etc.,

Sir :

In compliance with the call of your City Council, I have made a thorough examination of your sewerage system, and I beg to submit the following report :—

HISTORY.

So long a time has elapsed since the present system of Sewerage was begun, that it may not be amiss to recall its early history.

My first connection with the subject was late in 1879, when I came to Memphis as the Engineer of a Committee of the National Board of Health, which was charged with the recommendation of Sanitary Improvements, intended to prevent a recurrence of the epidemics of Yellow Fever, which had, for two successive years, devastated the town, ruined its prosperity, and greatly reduced its population.

Those who have known Memphis, only after the regeneration that followed that period, can form little idea of the sad plight, in which this great disaster had left it. Its sanitary condition had never been good, and when the people began to return to their homes, after the exodus of the second fever year, it was as bad as it could be. The spirit of the leading men of the City, at that time, was, however, most admirable. They determined that the stricken town should be put again upon its feet and that a right start should be made in the effort to regain its strength. They foresaw the advance that was possible, and, to pave the way for it, they decided that whatever the Board of Health Committee should advise must be carried out.

The splendid modern City of to-day, is a monument to their manly and resolute effort,—the full value of which can be appreciated only by the few who know the woeful condition from which they have raised it.

It was decided that the first work of improvement should be the con-

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struction of a system of sewerage. But sewerage was very costly, and the community was very poor. Some years before, a plan of sewerage had been made which would cost enormously more than it was possible to pay; there was no method of city sewerage then in vogue by which what was determined to be immediately necessary could be constructed for less than one-half million dollars; less than one-half this amount was available.

I had formulated a theoretical system, which had never been put into execution,—which probably never would have been put into execution, but for the great needs and the great poverty of Memphis.

This system consisted of small earthen ware pipes, carrying foul sewerage only, from which all rain water was rigidly excluded, and in which the occasional, irregular and unreliable flushing during rains was to be replaced by the daily discharge of automatic flush-tanks at the heads of all the branches of the sewers. It was accepted by the Board of Health Committee, of which Dr. J. S. Billings was Chairman; it commended itself to the health authorities and to the leading citizens; and its adoption was urged upon the Council.

Many a hard battle had to be fought against ignorance, timidity and stupidity, before the order for its construction was finally given. I made three separate visits to argue in its favor,—twice before the Council, and once before a large meeting of citizens at the Cotton Exchange, where it was, after a long and hot discussion, accepted by an acclamation, against which only one single "No" was raised.

The discussion concerning details was long protracted. In the course of this, it was determined that in view of the defective water supply from Wolf River, which was then in use, it would be an ample allowance to provide for a water consumption of forty gallons per person, per day, or 2,000,000 gallons for a population of 50,000;—the actual daily consumption, at the present time, is more than 6,000,000 gallons.

My original estimate provided for a full supply of man-holes, costing, as I remember, about \$15,000.

It was decided that we could get along with some cheaper substitute, and that if man-holes were found to be necessary in future, the richer future city could afford to build them; so the man-holes were omitted. For a like reason, the main sewers were confined to a size barely sufficient for the two million gallon capacity. I remember that Dr. Porter argued before the Council that it was a great advantage of the system that it could be built with main sewers adapted to present needs, and that supplemental mains could be laid when they were needed, and when the City could better afford to build them.

At last, the order was given, and ground was broken on the 21st of January, 1880. I gathered a party of eighteen assistant engineers, from various parts of the country, only two or three of whom had ever done any sewer work, and none of whom had ever seen such sewers as we were to build here. Men, materials and tools were collected in great haste, and a rush was made to put in as much sewerage as possible before June 1st, which the Board of Health fixed as the latest time at which it would be

admissible to stir up the polluted soil in this hot climate. We worked for about twenty weeks, fully five weeks of which time was lost by bad weather, generally heavy rains. This rainy weather was so distributed that the ground was in a very bad condition nearly all the time.

During fifteen weeks of actual working time, in spite of innumerable difficulties, we invented our processes, organized our forces, procured our supplies, and built more than eighteen miles of sewers, including the brick main from the jail to Jackson street, and the two main sewers east and west of Bayou Gayoso; we did this at a cost including the engineering and superintendence of less than \$140,000.

If time has shown that something less than absolute perfection was secured, here and there, I think it may still be said, that considering all the circumstances, we did reasonably well.

The work then done had its desired effect of aiding to improve the Sanitary Condition of Memphis, and of showing to the world, that this condemned city had taken on a new life, that it was earnest in its determination to overcome the disastrous effects of its epidemics, and that it offered a hopeful field for enterprise. During the thirteen years that have since passed, it has maintained its promise, and from that moment of its regeneration, it has gone bravely on and has, by its prosperity, astonished the world, which in 1879, would have been glad to see it swept off the face of the earth, as a dangerous public nuisance.

The work then done has had another effect. It has revolutionized the methods of sewerage of the smaller towns. Not only have the principles first set forth here in 1880 been adhered to, in the construction of the thirty-two miles of additional sewers built in Memphis by the City's own engineers, but the same system has been adopted in all parts of the country, until it is safe to say that, in work executed and now in hand, the total length of similar sewers is not less than 1000 miles.*

It has attracted attention, and has found some imitators in other countries, and the name of Memphis is known, because of its sewers, in some quarters to which its fame would not otherwise have penetrated.

Naturally, as with all new processes, modifications have been made in the arrangement, construction and maintenance of this system, and these modifications have generally been improvements, but in its essential features the system remains the same today that it was when first adopted here in 1879.

These features are:

1. The use of pipes so small that the stream sent through them will flush them sufficiently.
2. The exclusion of storm water.
3. The substitution of regular *automatic* flushing for rain or hand flushing.

*In the sewerage of the Chelsea district of Memphis, Mr. R. Frank Hartford, who began the work, used 8-inch pipes for the lateral sewers. His successor, becoming familiar with the excellent service rendered by the 6-inch sewers in the older work, has gone back to this smaller size in Chelsea, save on lines which are to serve as submains in future extensions.

These features will, in my judgment, come more and more into favor as time goes on.

This is the system that you have in use in Memphis, crude in some regards, as it was learning its first paces at the hands of inexperienced men a dozen years ago along the slopes of Bayou Gayoso, and doubtless more complete and workmanlike, as the experienced engineers of the City have constructed it in other portions. On the whole, I think we all have good reason to be satisfied with it.

THE EXAMINATION.

I have been invited to make a careful inspection of the sewers in their present state, and to make such recommendations concerning them as seemed to be proper.

To this end, I have gone carefully over the work with your Honor and with Major Meriwether and Mr. Elliot. I have been given the fullest opportunity to see all that I desired to see, and the fullest and frankest information has been cordially furnished me. I find that there are now in service 50½ miles of sewers of the system under consideration.

There are in connection with the system 253 flush tanks and 478 man-holes; there are about 7000 house connections. The house connections receive the wastes of the following fixtures:

Water Closets, 9672.

Slop Sinks and Catch Basins, 6920.

Bath Tubs, 1149.

Waste Basins, 840.

Urinals, 666.

Laundry Tubs, 104.

Latrines, 12.

It is to be said, in a general way, that the lateral sewers of the system have ample capacity for their work. It is reported that they never run half full, and that they rarely run one-third full. The brick sewer runs about half full, and the east and west mains run less than full, when they are not gorged with water from rains, and when they are clean. Some years ago, the east and west mains were intercepted at Monroe street by a sewer running through that street to the river; but for this interception the mains north of Monroe street would now be overtaxed most of the time.

In one respect these sewers are called upon for a duty they are not intended to perform; that is the removal of a large amount of storm water. In spite of the most careful, proper and sufficient regulations, with sufficient penalties, provided for by the Ordinance passed in 1880, the plumbing and drain-laying work on private property was for years allowed to take care of itself. Any kind of plumbing and any kind of drain-laying, for which the most penurious owner employed the most incompetent mechanic, was allowed to be done by the utterly neglectful sewer department.

R. Frank Hartford, Engineer of that Department, said in his report of 1888, "In conclusion, I earnestly recommend that a skilled inspector be

employed to examine, test and report upon the work done under the plumbing ordinances. Bad practice has now become the common practice, and it is clearly attributable to lack of intelligent supervision. Our force is too small to make this.

"It is certain that poor and illegal work is costing this Department a large sum each year for cleaning and repairing sewers, and it is not improbable that it has caused, prematurely, our overcharged mains."

He told me, soon after that time, that he was not allowed the help needed to control the plumbers, and could not be held responsible for what was done. He had protested against these practices, but was powerless to enforce a proper compliance with the Ordinance.

The property owners of Memphis must, now or later, repay, with heavy interest, the amounts saved by their former parsimony in this matter.

The sewerage system will never be satisfactory until these gross defects are remedied. I am glad to see that, under the present administration, the President of the City and the Engineering Department are upholding Mr. Lunn in his efforts to secure an absolute compliance with the rules and regulations established concerning the methods of house plumbing, and of connecting private premises with the public sewers. Success in this direction means success to the whole system of sanitary drainage, and the establishment of health-conditions, which have always been aimed at, but which have heretofore not been fully secured.

In addition to the bad sanitary conditions sure to follow neglect in this matter, especially in the case of the poorer tenements,—and these are the usual starting points of epidemics,—the injury to the sewer system has been most serious. Aside from the obstructions to the proper flow of the sewers, of which Memphis has had an unprecedented crop, there has also resulted, from careless work on private property, a great inflow of storm water during and after every heavy rain. In some cases there is leakage about the fixtures, especially about and over the tops of yard catch-basins. In others, rain water leaders have been wilfully discharged into catch-basins; and in very many more cases the connecting drain in the ground, leading from the fixtures to the public sewer connections, is laid with leaky joints, so that it acts as an under-drain, and carries to the sewer the water saturating the ground after rains. I judge that the amount of water thus introduced into the sewers within two or three days after a heavy rain amounts to at least four or five times as much as the flow of sewage proper within the same period.

This extraneous inflow should be stopped, at any necessary cost. In the matter of obstructions due to the former neglect of proper control above referred to, Memphis leads the world; there are more stoppages here per mile of sewerage in one week, than occur in towns where the system is properly guarded in a whole year.

For example, Stamford, Connecticut, has about twelve miles of six inch sewers, which have been in use for about six years. It is a flat town, and most of the sewers are laid on a slight inclination. The Warden told me last month that they never had a single stoppage in the sewers, and only

three in the house drains,—due to the gross carelessness of the users. The house drains of Memphis may be, and should be, made so good as to produce the same result here. The man-holes and inspection pipes of Stamford have never been opened except from curiosity; not one of them has ever been *used* since the work was finished, and this is the experience of many other towns having this system of sewerage.

So far as the sewers themselves are concerned, in Memphis, their chief defect seems to me to be that they are not adequately flushed. The flush tanks discharge from 110 to 130 gallons, and the discharge occupies probably from 45 to 75 seconds. This was originally supposed to be sufficient, but experience here, as well as elsewhere, has shown that it is not so. The whole discharge should be as much as 150 gallons and it should be shot into the sewer in 20 seconds or less. The siphon available when this work was done was not quick enough in its action, but we have a siphon now in use which will discharge 150 gallons in from 13 to 15 seconds.

Under the conditions now existing in Memphis, the lateral sewers accumulate deposits, and these deposits foster the growth of a troublesome fungus; this fungus and the deposits accumulate during dry weather. When a heavy rain falls, enough of its water runs into the laterals to wash much of this accumulation into the main sewers, where the man-holes help to prevent its immediate and complete removal. The mains are then gorged,—sometimes to overflowing, until, by repeatedly passing the wire brush through the pipes, the obstructions are cleaned out. The sub-mains and laterals are then brushed, and the system works properly, until another period of accumulation, followed by a rain, leads to another condition of obstruction. So long as the sewers receive the intelligent and careful attention now bestowed on them, they will continue to perform their work, as they now perform it.

Something much better than this, however, is needed to constitute such a perfect sanitary system of sewerage as Memphis should have. The sewers should keep themselves clean; they should not be dependent upon intelligent care. While they remain thus dependent, however, a larger force of workmen should be at the disposal of the Engineer having charge of them. The present small force is not able to do the work properly.

RECOMMENDATIONS.

First:

More efficient flushing should be provided. The present tanks discharge into the sewers an average of about 120 gallons in about 50 seconds, or at the rate of 2.4 gallons per second. Tanks should be constructed which would deliver 150 gallons in 20 seconds, or at the rate of $7\frac{1}{2}$ gallons per second. 150 gallons would fill about 115 feet of 6 inch sewer entirely full, and such a discharge would have a scouring effect very materially greater than that of the present flush. This, when delivered with such rapidity, would, in conjunction with an occasional ball cleaning, keep the sewers in better condition than it is possible to secure by manual labor.

The renewal of the tanks would not cost more than about \$10,000. Aside from the much needed improvement they would effect, they would save an annual outlay of over \$2,000, or the interest at 5% on \$40,000. They would maintain the sewers in a state of cleanliness that could not be approached by any practicable brushing by hand. I think this the most important improvement to be made.

Second:

Openings should be made in the house connections, near the property line, with suitable movable covers, and with the aid of these openings the flow of water during and after rains should be so examined, as to determine whether or not surface water, or underground drainage is flowing to the sewers from any given private premises.

Strenuous measures should be taken to prevent such flow, by requiring property owners to provide other means for the discharge of rain water. The sewers are not intended for such use, and they cannot be so used without interfering with their efficiency for their legitimate service.

Third:

Obstructions should, wherever possible, be traced to their origin, and the plumbing fixtures and slop sinks of offending parties should be so arranged as to prevent a further admission of articles large enough to cause obstructions in the public sewers.

Fourth:

With all their advantages, man-holes have in some cases drawbacks that it would be well to remedy; especially on the east main, and, to a less degree, on the west main. The sewage, in time of excessive flow, rises in the man-holes considerably higher than the sewer, and a pool of sewage rises and stands in each of them. Floating filth rises to the surface of each pool and makes the man-holes very foul. As the flow recedes this filth is carried into the sewer in masses which may accumulate and obstruct the flow.

In cases where this is likely to happen,—in all cases, that is, where the flow rises above the benches of the man-holes,—the channel through which the sewers pass should be covered with iron plates laid on the benches, to keep the solids within the course of the moving current, so that they may be carried to the outlet. Such plates, properly supplied with lifting-staples, could be conveniently handled.

I would suggest that, so far as the people have been permitted to acquire careless habits, and to think that they can with impunity disregard the provisions of the Ordinance of Section 258 f., and Section 259 (of 1880) and the Rules and Regulations based thereon, they should be given to understand that such impunity can no longer exist; and that a rigid enforcement of the pains and penalties attached thereto be ensured.

While this might be found to be a difficult and unpleasant duty for the authorities, it would soon lead to a reform of the greatest value to the community, at all times, and especially now, when the menace of cholera and the possibility of a recurrence of yellow fever are to be apprehended.

SOUTH MEMPHIS.

I have been asked to express an opinion as to the sewerage of the large occupied tract in the Southern part of the City, beyond the reach of the present system of sewers.

The problem there presented is too important and contains too many factors to be solved at sight, without a careful study of the topographical conditions. The best economy and efficiency of such work requires careful and exact study. There cannot, however, be two opinions as to the great importance of the project. So far as I can judge from a cursory examination, I fully concur in the recommendation of President Clapp, that this district be furnished with a main sewer of its own, discharging into the river at some suitable point, considerably north of Calhoun street. Such a sewer should be of sufficient size to accommodate not only the sewage of the dense population in the district in question, but also for all populations that may hereafter reside in the district south of the present City limits, as far as the ridge dividing the drainage basin of Wolf River from the basin of the Nonconnah.

In connection with this suggestion, it is proper to say that the present Monroe street intercepting sewer is capable of receiving the sewage of the southeastern portion of the present City; but another will be required for the sewerage of low lands along Bayou Quimby, which seems to afford the best outlet for the sewerage of the district immediately east of the City.

In closing, I desire to express my thanks to the Engineering Department, for its cordial aid in my examination, and to say that I have been expressly impressed with the intelligent and interested manner in which Mr. Elliot has employed the somewhat inadequate means at hand in overcoming the difficulties in connection with the sewers, to which I have referred herein.

I believe that he realizes the effect of the courses that were pursued prior to his assumption of the duties of his office, and that, so far as he is able to control matters, the effects of former negligence will be reduced to a minimum.

It is hardly necessary for me to say that, on however good a system sewers may be built, they cannot be trusted to keep themselves clean without some help or supervision, neither can they be expected to cope with the carelessness and heedlessness of those who use them. This difficulty can be properly met, only by the supervision of an intelligent Engineer, armed with authority to enforce rules, and controlling a sufficient force to maintain good conditions.

Respectfully submitted:

GEO. E. WARING, JR.,
Consulting Engineer.

MEMPHIS, March 4th, 1893.